DISTURBANCE OF SOIL ORGANIC MATTER AND NITROGEN DYNAMICS: IMPLICATIONS FOR SOIL AND WATER QUALITY (CS1114D)

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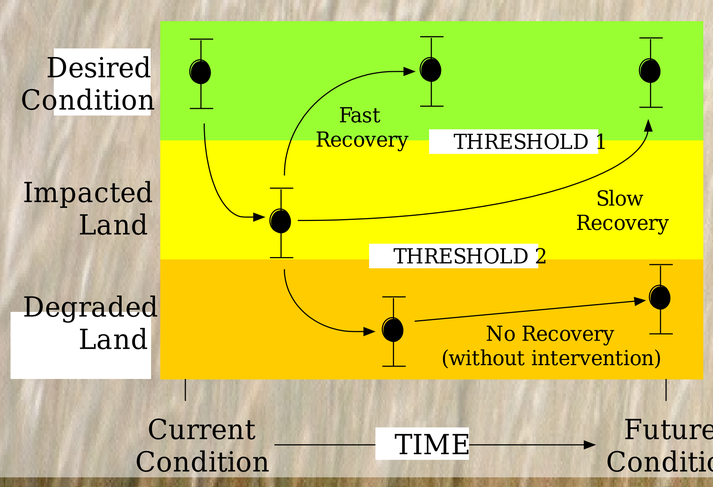
OVERVIEW

- Goal is to develop a better understanding of the effects of disturbance on key measures of soil quality and to determine whether there are thresholds to soil quality below which ecosystems are not sustainable.
- Soil quality is “the capacity of a soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality, and promote plant and animal health”.
- Soil organic matter (i.e., soil C) and nitrogen (N) are critical determinants of soil quality because of their relationship to soil structure and nutrient supply for plants and soil microorganisms.
- Recovery of soil quality following disturbance is closely associated with the rate and capacity for soil organic matter accumulation.

RESEARCH TASKS

- Characterize the effect of disturbance and land use on key measures of soil quality (soil C and N).
- Determine thresholds that establish the potential for recovery of soil quality following site disturbance.
- Build simple dynamic models for different land use/land cover categories to predict recovery of soil quality on disturbed lands.
- Plan long-term field experiments to test models used to predict the recovery of soil quality following site disturbance.
- Use GIS resources as a tool for spatial analysis of soil C and N dynamics to predict effect of site disturbance and land use change on soil quality.

THRESHOLD CONCEPT FOR MEASURES OF SO



APPROACH

- The research is focused on soil C and N dynamics under different disturbance regimes and different land use/land cover categories at Fort Benning, GA.
- Measurements of soil bulk density, soil C and N stocks, and soil N dynamics along gradients of disturbance and land use change.
- Using lab techniques, soil C inventories are partitioned into pools with different turnover times (labile, organomineral, and refractory soil C).

  - LECO CN-2000, Perkin Elmer 2400 Series II CHNS/O analyzer
- Soil N availability is assessed by measuring potential net soil N mineralization and nitrification in laboratory incubations.
- Field data are incorporated into computer model of soil C

PROGRESS FY00 (First Year)

"Threshold values for key indicators [of soil quality] must be established with th knowledge that these will vary dependin upon land use, the specific soil function greatest concern, and the ecosystem or landscape within which the assessment i being made." (Doran and Parkin, 1996)

Examined differences in soil quality at 1 sites classified into 5 levels of military disturbance (reference, light-use, moderate-use, heavy-use, and remediated)

Examined differences in soil quality at 4 sites classified into 5 categories of land use/land cover (deciduous forest, evergreen forest, mixed forest, transitional vegetation, and barren land 32 sites near LCTA plots

FINDINGS RELATED TO LAND USE/LAND COVER

- Significant land use/land cover differences in surface soil bulk density with the greatest surface soil compaction under barren land, evergreen forests, and transitional land.
- Only minor land use/land cover differences in soil texture (most of the soils had high sand content - particularly barren sites).
- Measurements of potential net N mineralization indicated more soil N availability under deciduous forests, mixed forests, and transitional vegetation than under evergreen stands and barren land.

FINDINGS FROM DISTURBANCE GRADIENT (see second panel)

- Reference and light-use sites were similar with respect to all measured soil properties, except soil bulk density.
- Surface soil bulk density was significantly greater at heavy-use, moderate-use, and remediated sites (including soil compaction).
- SoilC concentrations and stocks increased in the following order: Heavy-use < moderate-use = remediated < light-use = reference.
- Amounts of C and N in particulate organic matter (POM) were similar at reference and light-use sites but significantly lower at heavy-use, moderate-use, and remediated sites.
- Along a pine forest chronosequence, the fraction of whole soil C in POM and POM-C stocks increased with stand age.
- Soil C:N ratios, as well as soil C concentrations and stocks, indicated some recovery of soil quality at moderate-use and remediated sites.

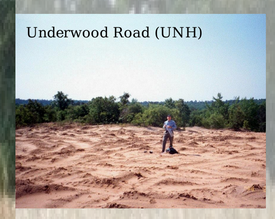
ACKNOWLEDGEMENTS

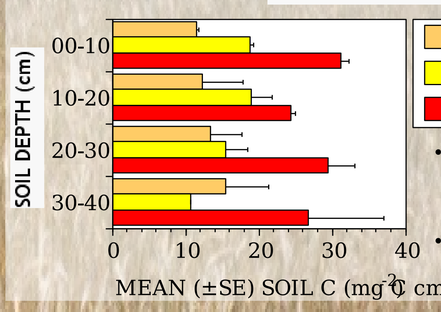
This research was sponsored by the Strategic Environmental Research and Development Program (SERDP) under contract DE-AC05-00OR22725 with Oak Ridge National Laboratory, managed by UT-Battelle, LLC. SERDP is funded by the U.S. Department of Defense, in partnership with the U.S. Department of Energy, and the U.S. Environmental Protection Agency. Virginia Dale (ORNL) contributed her soil samples from the Fort Benning disturbance gradient for our analysis. Suzanne Beyeler and Patty Kosky helped with field tasks. We wish to thank Bonnie Lu (ORNL) along with student interns Deanne Brice and Kevin Smith for their contributions in the laboratory. Teresa Davo (Fort Benning) provided invaluable assistance in identifying LCTA sites and interpreting associated LCTA data from Fort Benning. We also wish to acknowledge the gracious assistance of Fort Benning, especially John Brent and Pete Swiderek, as the host field site

PROGRESS FY01 (Second Year)

- Focused on the objective of determining thresholds for soil quality
- Soil sampling along disturbance gradients and at sites where NRCS restoration activities are planned or underway
- Soil sampling at 10 sites (+ controls) harvested to control southern pine beetle (3 10-yr old, 5 5-yr old, and 2 1-yr old)
- Soil sampling at 16 sites within the proposed K11 Experimental Disturbance Area
- R&D on a model that links soil C and N dynamics for the purpose of predicting recovery of soil quality following disturbance and thresholds to soil quality

MEASURED RECOVERY OF SOIL C UNDER GRASS

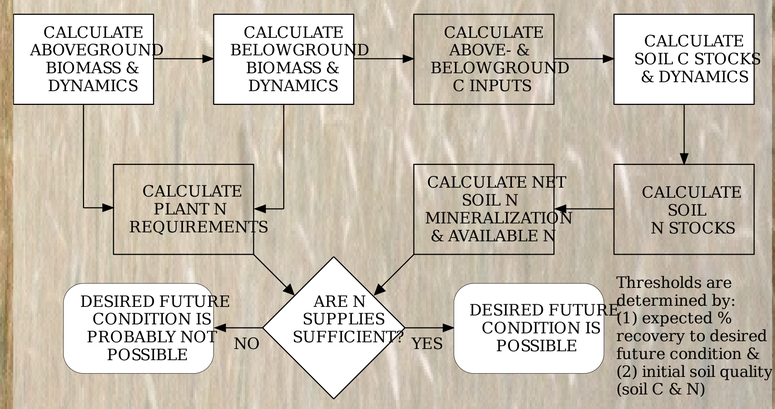




- Surface soil C stocks under grasses year after establishment) are great than those at nearby barren sites
- Soil C stock under grass (0-30 cm) 85 mg C cm^{-2} and that under barren land ranged from 37 to 53 mg C cm^{-2}

THRESHOLD MODEL LOGIC

- Define desired future condition (community, biomass, litterfall, rate & extent of recovery)
- Define initial conditions (labile, organomineral, and refractory soil C)


CALCULATE ABOVEGROUND BIOMASS & DYNAMICS
CALCULATE BELOWGROUND BIOMASS & DYNAMICS
CALCULATE ABOVE- & BELOWGROUND C INPUTS
CALCULATE SOIL C STOCKS & DYNAMICS
CALCULATE PLANT N REQUIREMENTS
CALCULATE NET SOIL N MINERALIZATION & AVAILABLE N
CALCULATE SOIL N STOCKS
DESIRED FUTURE CONDITION IS PROBABLY NOT POSSIBLE
NO
ARE N SUPPLIES SUFFICIENT?
YES
DESIRED FUTURE CONDITION IS POSSIBLE
Thresholds are determined by: (1) expected % recovery to desired future condition & (2) initial soil quality (soil C & N)

MODEL DEVELOPED WITH ithink® ANALYST SOFTWARE FOR MAC AND PC MACHINES

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